REPORT R-1688

UNITED STATES ARMY

FRANKFORD ARSENAL

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES

II. Single Grain Extruded Charge

by

M. E. LEVY

and

W. WHITE

OMS Code 4110.16.8100.1.33

REPORT R-1688

JULY 1963

PHILADELPHIA 37, PA.

Requests for copies will be made to Defense Documentation Center, Cameron Station, Alexandria, Va.

The findings in this report are not to be construed as an official Department of the Army position.

REPORT R-1688

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES

II. Single Grain Extruded Charge

OMS 4110.16.8100.1.33

Prepared by:

M. E. Levy
M. E. LEVY
Chemist

W. White
W. W. WHITE
Chemist

Reviewed by:

C. W. DITTRICH
Chief
Propellants and Explosives Section

W J Kroeger
W. J. KROEGER
Director
Pitman-Dunn Institute for Research

Approved by:

C C Fawcett
C. C. FAWCETT
Technical Director
Research and Development Group

R E Bassler Jr
R. E. BASSLER, Jr.
Lt Colonel, Ordnance Corps
Chief
Research and Development Group

For

GEORGE H. PIERRE, Jr.
Colonel, Ordnance Corps
Commanding

RESEARCH AND DEVELOPMENT GROUP
FRANKFORD ARSENAL
Philadelphia, Pa.

July 1963

ABSTRACT

An integrated assembly of a single, extruded, multiperforated, propellant grain and the required igniter charge was developed which met the ballistic specifications at normal temperature for the M91 cartridge for propellant actuated devices. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, widespread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

INTRODUCTION

In view of the severe vibration conditions to which PAD systems employed in the rocket and missile field are subjected, a program was undertaken to develop a PAD cartridge capable of withstanding extreme vibration without impairment of properties or performance. The M91 cartridge was selected as the test vehicle since it is used in the miniature initiator (M27/M28) designed to replace the widely used M3 initiator. A modified version of the M91 cartridge, incorporating an inert, polyethylene insert to provide increased vibration resistance for the loose multiperforated propellant, was previously developed for Project Mercury.[(1)*] It was believed, however, that additional improvement could be attained by developing a charge specifically designed for vibration resistance, thus obviating the need for the inert separator. Furthermore, there was a question as to whether the nitrate ester propellant used in the modified cartridge would provide adequate thermal stability.

A program was therefore undertaken which resulted in the development of integrated propellant charges bonded to the case wall. Bonding in this manner provided a cartridge having high vibration resistance since the charge vibrated in unison with the case. Standard PAD cartridges, on the other hand, are assembled with loose granular propellant and black powder which move freely in the case and are subjected to substantial case impact during vibration.

Two parallel approaches to the integrated charge development were followed. One was based upon a single grain molded from small granulation extruded propellant; the other, upon a single extruded multiperforated grain. The development of a molded charge, which met ballistic requirements and yielded improved thermal stability and vibration resistance, is described in a previous report.[(2)] In the molded grain approach, the required high mass burning rate was met by an integrated propellant-binder charge which burned in accordance with the characteristics of the granular propellant. The investigation described herein concerns the development of an integrated assembly of a single extruded grain and igniter charge. Due to funding limitations, this phase of the investigation was not carried to completion. However, the feasibility of such an approach was demonstrated.

---

*See REFERENCES.

APPROACH

Since the objectives of the program stipulated both high vibration resistance and thermal stability, composite solid propellant formulations which offer high thermal stability were used in the development of the single extruded grain charge for the M91 cartridge. Previous work had shown that composite solid propellants (consisting primarily of a high energy oxidizer, embedded in a fuel binder) exhibited greater thermal stability than nitrate ester types.[2, 4, 5]

The shaded area in Figure 1 illustrates the volume available for a single grain charge (of simple cylindrical form) in the M91 cartridge.

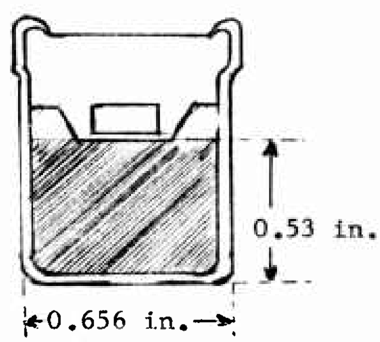

Figure 1. Schematic Diagram of M91 Cartridge

An extruded grain occupying the full available volume would weigh substantially more than the standard loose granular propellant charge (approximately 30 grains). Consequently, it was decided to control the charge weight of the single extruded grain primarily through its height, with the outer diameter of the charge similar to that of the case to permit bonding between the lateral surface of the grain and the case. In view of the high rate of gas evolution required in this cartridge, a multi-perforated configuration was employed to attain a large burning surface in the single grain. It was planned to investigate 7- and 19-perforation configurations, the latter to be used if the 7-perforation type did not provide sufficient burning surface. Since the 7-perforation geometry yielded the required gas generation rates, no work was conducted with the other type.

Black powder, which offered satisfactory thermal stability for the purposes of this program, was initially used as the igniter charge. However, it was determined that a more efficient booster was required for ignition of the single extruded grain. Consequently, the black powder was replaced by a boron-potassium nitrate igniter.

Test firings of the various propellant systems were conducted by assembling the M91 cartridge in an M27 initiator, to which was attached a 15-foot length of No. 4 rubber-lined aircraft hydraulic hose connected to an Aberdeen Proving Ground 1.0 cubic inch volume test fixture, which was fitted with a piezoelectric gage.

Ballistic requirements for this cartridge call for minimum individual pressures of 500, 575, and 625 psi at -54°, 21°, and 71° C (-65°, 70°, and 160° F), respectively, when fired in the standard test fixture.[3] While there is no requirement regarding the maximum gas pressure, a value less than 1500 psi is considered desirable. Standard M91 cartridges which contain the ammonium perchlorate-based HES 5808.7 propellant generally yield pressures of approximately 1000 psi at 21° C. In addition, it is required that the ignition delay of each cartridge should not exceed 65 milliseconds. This value is defined as the time between firing of the primer and the beginning of a continuous pressure rise on the pressure-time trace. All test firings in this investigation were conducted at 21° C.

RESULTS

Preliminary firings were conducted with various multiperforated composite propellants of ammonium perchlorate-cellulose acetate and RDX-cellulose acetate compositions. Previous studies[2, 4] indicated these two types had similarly high levels of thermal stability. Since these propellants had dimensions similar to those of the standard ammonium perchlorate-cellulose acetate HES 5808.7 propellant, they all yielded loose fitting charges of individual propellant grains when loaded into the M91 cartridge. The compositions and dimensions of the different propellants, all of which were graphite coated, are shown in Table I.

The results obtained with the various propellants are shown in Table II. In all cases, the standard igniter charge of 6 grains A4 black powder was added.

TABLE I. Description of Experimental Multiperforated Propellants[a]

	HES 5806.2	HES 5811.1	HES 5807.2	HES 5808.1
Composition (%)				
RDX	80	82	84	-
Ammonium perchlorate	-	-	-	84
Cellulose acetate	15	13.5	12	12
Methyl phthalyl ethyl glycolate	5	4.5	4	4
Dimensions				
Outer diameter (in.)	0.196	0.199	0.196	0.186
Perforation diameter (in.)	0.012	0.013	0.013	0.014
Mean web (in.)	0.040	0.040	0.039	0.036
Length (in.)	0.483	0.480	0.484	0.485
No. of perforations	7	7	7	7
Avg wt per propellant piece (gr)	5.00	4.85	5.24	5.41

[a]Source: Hercules Powder Company

TABLE II. Ballistic Results with Loose Propellants

Propellant	No. of Pieces	Weight (gr)		Peak Pressure (psi)	Ignition Delay (msec)	Rise Time (msec)
HES 5806.2	6	30		No detectable pressure, unburned propellant		
					Ditto	
					Ditto	
					Ditto	
				950	16	11
HES 5811.1	6	29		940	14	10
				960	14	10
				900	13	10
				940	15	10
				900	15	8
			Avg	928	14	10
HES 5807.2	6	31		1100	13	10
				1230	12	11
				1070	13	11
				1030	12	9
				1200	16	9
			Avg	1126	13	10
HES 5808.1	6	32		920	17	11
				900	18	14
				950	19	14
				940	19	13
				900	13	12
			Avg	922	17	13

HES 5806.2, the propellant having the lowest RDX content, yielded incomplete combustion in four out of five firings. All of the other propellants gave satisfactory performance. Mean pressures were similar to those obtained with the standard cartridge (approximately 1000 psi).

Cases loaded with the RDX-based propellants were difficult to remove from the initiator after firing; those containing the ammonium perchlorate-based propellant were easily removed. This sticking is probably due to the formation of a solid reaction product which deposited in the narrow free space between the inner wall of the initiator and the outer wall of the case.

It was therefore decided to employ the ammonium perchlorate-cellulose acetate formulation (HES 5808) in the development of a single extruded multiperforated grain, having an outer diameter similar to the inner diameter of the M91 case. Attempts to extrude 7-perforated HES 5808 grains in this large diameter were unsuccessful. The grains were brittle and cracked upon drying. Substitution of a polyacrylic rubber binder (Hycar 4021)*, composed of a copolymer of acrylic acid ester and a halogen-containing derivative, removed the processing difficulties, permitting preparation of large diameter multiperforated propellant sticks. (The propellant composition used, identified as HES 6405, was developed under a concurrent project directed toward heat resistant propellants.)[6]

The composition and physical dimensions of the large diameter propellant, designated HES 6405.6, are given in Table III.

Desired charge weights were obtained by cutting the propellant stick to various lengths. The ends of the cut pieces, consequently, had no graphite coating. The cut pieces were bonded to the case using a solution of cellulose acetate in an equal volume mixture of acetone and ethyl alcohol. Since the extruded piece (0.581 in. diameter) was considerably smaller than the case diameter (0.656 in.), bonding occurred primarily at the base. The bonded charges adhered firmly to the case and could not be dislodged by either hand or mechanical agitation. Various weights of A4 black powder (6, 8, and 10 grains) were then added. Firings were conducted and the results are shown in Table IV.

---

*Source: B. F. Goodrich Chemical Company.

TABLE III. Description of HES 6405.6 Propellant[a]

	Composition (%)
Ammonium perchlorate	84.00
Hycar 4021	15.55
DMP-30 (tri-dimethylamine methyl phenol)	0.35
Sulfur	0.10
Graphite glaze (added)	0.10
	Dimensions
Outer diameter (in.)	0.581
Perforation diameter (in.)	0.051
Inner web (in.)	0.133
Outer web (in.)	0.081
Length (in.)	4
Number of perforations	7

[a]Source: Hercules Powder Company

TABLE IV. Firings with Extruded HES 6405.6 Grains
(Black Powder Loose in Cartridge)

Weight (gr)		Peak	Ignition	Rise
HES 6405.6 Propellant	A4 Black Powder	Pressure (psi)	Delay (msec)	Time (msec)
25	6	400	9	18
25	8	740	10	12
25	10	520	13	12
28	6	600	14	19
28	8	510	13	16
28	10	1030	11	12
31	6	580	12	13
31	8	640	14	15
31	10	1220	10	16
34	6	1410	11	10
34	8	1560	8	8

All charges ignited readily; however, low pressures were obtained with propellant charges of 31 grains or less and 6 or 8 grains black powder. The fact that the 10-grain black powder charge with 28 and 31 grains HES 6405.6 propellant yielded approximately twice the pressure obtained with the two lighter black powder weights indicated the importance of ignition in this system. Additional firings were conducted using propellant weights in the range 28 to 31 grains with black powder charges of 10, 12, and 14 grains.

To effect more reproducible ignition, shallow 0.003 in. thick plastic cups were made, having a diameter equal to that of the case. The black powder was placed in these cups and the top was sealed with an 0.003 in. thick adhesive cellophane material. The cups were then bonded with cellulose acetate to the top of the propellant grains and the grains bonded to the case. This arrangement provided for uniform ignition of both the top surface of the propellant grain and surface of the perforations. The results of test firings are shown in Table V.

Reproducibility appeared to be similar to that obtained with standard cartridges. Peak pressures were slightly greater than the desired level; however, these could be reduced through reduction in weight of the propellant and/or the black powder. Thus, the results indicated the feasibility of a single extruded propellant grain in the M91 cartridge.

Since the diameter of the HES 6405.6 propellant was considerably smaller than that of the case, it was decided to conduct further tests with a slightly larger diameter extruded propellant, fitting more tightly in the case. This propellant was cut to a length yielding pieces having an average weight of 30.2 ± 0.5 grains. Previous firings had indicated the required propellant charge would be approximately this weight. The dimensions of the propellant, designated HES 6405.9, are shown in Table VI.

Cartridges were assembled by bonding the bottom and lateral surfaces of the extruded grain to the case and then bonding selected weights of A3a black powder to the top surface of the propellant grain. The A3a black powder was substituted for the A4 type since it was believed that the slightly coarser granulation of the former would provide for improved ignition of the extruded grain. Hycar 4021 in an equal volume mixture of acetone and ethyl alcohol was used to bond the various constituents. The results of firings are presented in Table VII.

TABLE V. Firings with Extruded HES 6405.6 Grain

(Black powder contained in cup bonded to grain)

Weight (gr) HES 6405.6 Propellant	Weight (gr) A4 Black Powder		Peak Pressure (psi)	Ignition Delay (msec)	Rise Time (msec)
28	12		1400	7	9
			1430	7	9
			1340	6	8
		Avg	1390	7	9
28	14		1320	7	8
			1280	8	9
			1260	8	9
		Avg	1287	8	9
29	10		1140	11	13
			1200	10	14
			1260	9	13
		Avg	1200	10	13
29	12		1340	7	11
			1440	7	10
			1340	6	9
		Avg	1373	7	10
31	10		1610	9	10
			1420	9	9
			1470	9	10
		Avg	1500	9	10

TABLE VI. Dimensions of HES 6405.9 Propellant[a]

Outer diameter (in.)	0.607
Perforation diameter (in.)	0.062
Inner web (in.)	0.103
Outer web (in.)	0.108
Length (in.)	0.257
Number perforations	7
Average weight per piece (gr)	30.2

[a]Source: Hercules Powder Company.

TABLE VII. Firings with Extruded HES 6405.9 Propellant and Bonded Charges of A3a Black Powder

Weight A3a Black Powder (gr)	Peak Pressure (psi)	Ignition Delay (msec)	Rise Time (msec)
8	640	14	13
	510	16	12
	590	20	11
	600	9	13
	580	12	11
10	480	14	15
	900	13	12
	580	11	14
	980	11	9
	860	11	11
12	1080	9	11
	980	9	11
	880	12	12
	1040	10	10
	680	10	12

Average values are not presented in view of the considerable variation in peak pressure obtained with the 10- and 12-grain black powder charges. While the pressures obtained with the 8-grain black powder charge were uniform, they were undesirably low. Increasing the charge produced a shift to higher pressures; however, individual low values were still obtained. Thus, while ignition with the 8-grain charge was probably insufficient, ignition with the 10- and 12-grain charges was marginal, causing the wide pressure variations.

Previous firings with 10- or 12-grain A4 black powder charges and similar weights of HES 6405.6 propellant (see Table V) yielded satisfactory uniformity. Furthermore, the pressures were greater than even the "high" values obtained with the HES 6405.9 propellant. This difference was believed attributable to either of two factors. The slightly greater diameter of the HES 6405.9 grain (0.607 in.), as compared with that of HES 6405.6 (0.581 in.), could have resulted in a lower gas generation rate with the former since its tighter fit in the case may have precluded adequate ignition and burning of the outer surface of the grain. The other factor may have been that the black powder in the HES 6405.9 firings was directly bonded to the propellant surface. Previously, it was loosely contained in a sealed cup which was bonded to the propellant. Bonding of the black powder may have reduced its ability to ignite effectively the extruded propellant grain. While the black powder granulation had also been changed, it was not believed the slightly coarser granulation of the A3a would cause the difference in performance.

To determine the effect of bonding, cartridges were assembled in which similar weights of A3a black powder were added loosely or affixed to the top surface of case bonded HES 6405.9 propellant grains. As before, Hycar 4021 was used as the binder. The results of firings are presented in Table VIII.

TABLE VIII. Effect of Loose and Bonded A3a Black Powder on Ballistic Performance of HES 6405.9 Propellant

Weight A3a Black Powder (gr)	Form	Peak Pressure (psi)	Ignition Delay (msec)	Rise Time (msec)
14	Loose	530	12	16
		660	13	16
		630	12	15
		970	11	12
		540	12	17
14	Bonded	660	12	15
		720	12	13
		680	13	14
16	Loose	580	11	13
		1040	12	11
		680	11	12
		590	13	15
		540	13	15
16	Bonded	1080	12	13
		690	10	13
		650	13	15

For equal weights, there was no significant difference between the peak pressures obtained with loose or bonded black powder. Erratic and low pressures were still obtained with black powder:HES 6405.9 propellant weight ratios of approximately 1:2. In view of this undesirably high weight ratio of igniter to propellant, it was decided to investigate use of other igniters requiring less charge weight.

Under a differenct project[6] it was found that M73 PAD cartridges yielded higher peak pressures when assembled with a boron-potassium nitrate igniter* than with similar weights of A4 black powder. The igniter grains, designated USF-2A, consist of 23.7% boron/70.7% potassium nitrate/5.6% binder (Laminac-Lupersol DDM in 98:2 ratio) and are pressed in the form of cylinders of 1/8 inch diameter and 3/16 inch length.

Cartridges were assembled using selected weights of USF-2A igniter bonded to the top of case-bonded HES 6405.9 propellant grains. Hycar 4021 was used as the binder for the different constituents. The results of firings are given in Table IX.

TABLE IX. Effect of Various Weights of Bonded USF-2A Igniter on Ballistic Performance of HES 6405.9 Propellant

Weight USF-2A Igniter (gr)	Peak Pressure (psi)	Ignition Delay (msec)	Rise Time (msec)
10	500	12	19
	590	15	17
	540	13	18
12	640	12	20
	620	13	16
	930	12	16
14	640	12	17
	630	14	23
	1050	12	23
16	1220	12	20
	1140	11	13
	1390	10	15

*Source: United States Flare Division of Atlantic Research Corporation.

A charge of 10 grains igniter yielded uniformly low pressures. Erratic pressures were obtained with both the 12- and 14-grain charges, indicating marginal ignition at these weights. However, the pressures obtained with the 16-grain igniter charge were relatively uniform and similar to those yielded by standard cartridges. Thus, for a 16-grain igniter charge, improved uniformity and higher pressures were obtained with the USF-2A igniter than with A3a black powder, indicating the increased effectiveness of the former in promoting the mass burning rate of the HES 6405.9 propellant grain.

The program was terminated at this point due to funding limitations. However, the results, while limited, indicate feasibility of attaining the desired ballistic performance using an integrated assembly of a case-bonded single, extruded, multiperforated propellant grain and igniter charge.

DISCUSSION

While the above system met ballistic specifications at 21° C, an undesirably high weight ratio of igniter to propellant (approximately 1:2) was required to effect adequate ignition and produce the required high gas generation rate. In view of the difficulty in adequately igniting the charge at this temperature, satisfactory functioning at the minimum of the required temperature range, -54° to 71° C, may constitute a problem. While no vibration tests were conducted, there is no reason not to believe that the case bonded, extruded grain will have, at least, the same high vibration resistance as did the case-bonded molded grain developed under this program.[2] Similarly, the single extruded grain should have high thermal stability as the HES 6405 composition was specifically developed for and was shown to have high temperature resistant properties.[6]

Since a single grain extruded propellant charge has to be specifically developed and manufactured for each cartridge (i.e., the grain dimensions and weight are fixed by the case dimensions and performance requirement), widespread application of this concept to various PAD cartridges does not appear warranted. Furthermore, extremely close processing control is required for those propellant grains having a high ratio of diameter of length. Slight variations in grain length may result in disproportionately large variations in charge weight.

CONCLUSIONS

An integrated assembly of a single extruded multiperforated propellant grain (HES 6405.9) and required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter charge bonded to the top surface of the grain.

While this concept has been shown to be feasible, widespread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

REFERENCES

1. D. J. Savory, "Development of Initiator, XM-41," Frankford Arsenal (report to be published).

2. M. E. Levy, J. B. Quinlan, W. White, and E. F. Van Artsdalen, "Development of Vibration Resistant Propellants for the M91 PAD Cartridge. I - Integrated Molded Charge," Frankford Arsenal, Report R-1663, December 1962.

3. "Cartridge, Initiator, T289," Frankford Arsenal, Purchase Description FA-PD-MI-2330, Rev 2, 30 June 1960.

4. M. E. Levy, "Development of Propellants of Improved Thermal Stability for the M73 CAD Cartridge," Frankford Arsenal, Report R-1567, August 1960.

5. M. Visnov, "PAD Propellants and Initiators for Use at High Temperatures. Part I. Screening of Propellants by Autoignition Tests," Frankford Arsenal, Report R- (to be published).

6. "Propellant Actuated Devices," Frankford Arsenal, Monthly Progress Reports (Project C171), 1961.

DISTRIBUTION

1 - Hq, U.S. Army Materiel Command
Attn: AMCRD-RS-CM, M. Miller
Washinton 25, D. C.

1 - Attn: AMCRD-DE-W

1 - Hq, U.S. Army Munitions Command
Attn: AMSMU-AP, J. E. Rainier
Picatinny Arsenal
Dover, N. J.

1 - Commanding General
Picatinny Arsenal
Attn: Technical Library
Dover, N. J.

2 - Commanding General
U.S. Army Test & Evaluation Command
Attn: Technical Library
Aberdeen Proving Ground
Md.

1 - Commanding Officer
Harry Diamond Laboratories
Attn: AMXDO-TIB
Washington 25, D. C.

1 - Bureau of Naval Weapons
Department of the Navy
Attn: RMMP
Washington 25, D. C.

1 - Commanding Officer
U.S. Naval Propellant Plant
Attn: Research & Development Dept
Indian Head, Md.

1 - Commander
Naval Weapons Laboratory
Attn: R. I. Rossbacher, Code WC
Dahlgren, Va.

1 - Commander
U.S. Naval Ordnance Test Station
China Lake, Calif.

1 - Hq, U.S. Air Force
Attn: Dir, Research and Development AFDRD-AN
Washington 25, D. C.

1 - Attn: Dir, Maintenance Engineering AFFME-AR

1 - Commander
Air Research and Development Command
Attn: RDRAPR
Andrews Air Force Base
Washington 25, D. C.

1 - Directorate of Aerospace Safety
Attn: Ch, Life Sciences Gr (AFIAS-L)
Norton Air Force Base
Calif.

DISTRIBUTION (Cont'd)

3 - Commander
Aeronautical Systems Div
Attn: ASRMDD 13,
Capt D. R. Barron
Wright-Patterson AFB, Ohio

3 - Attn: ASNPSS, C. K. Hodell

1 - Attn: ASAPRL, Library

1 - Commander
2705th Airmunitions Wing (AMC)
Attn: OOYIT
Hill AFB, Utah

1 - Attn: OOYEC

1 - Director,
NASA Manned Spacecraft Center
Attn: Mercury Project Office
K. S. Kleinknecht
Houston, Texas

3 - Chemical Propulsion Information Agency
Applied Physics Laboratory
The Johns Hopkins University
Silver Spring, Md.

10 - Defense Documentation Center
Cameron Station
Alexandria, Va.

1 - Hercules Powder Co.,
Kenvil, N. J.

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus
OMS 4110.16.8100.1.33 Unclassified Report

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, widespread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus
OMS 4110.16.8100.1.33 Unclassified Report

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, widespread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus
OMS 4110.16.8100.1.33 Unclassified Report

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, widespread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus
OMS 4110.16.8100.1.33 Unclassified Report

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, widespread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus Unclassified Report
OMS 4110.16.8100.1.33

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, wide-spread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus Unclassified Report
OMS 4110.16.8100.1.33

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, wide-spread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus Unclassified Report
OMS 4110.16.8100.1.33

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, wide-spread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED

AD- ACCESSION NO.

FRANKFORD ARSENAL, Research and Development Group, Pitman-Dunn Institute for Research, Philadelphia, Pa. 19137

DEVELOPMENT OF VIBRATION RESISTANT PROPELLANTS FOR THE M91 CARTRIDGE FOR PROPELLANT ACTUATED DEVICES II. Single Grain Extruded Charge by M. E. Levy and W. White

FA Report R-1688, July 1963; 17 pp incl tables and illus Unclassified Report
OMS 4110.16.8100.1.33

An integrated assembly of a single, extruded, multi-perforated propellant grain and the required igniter charge was developed which met the ballistic specifications for the M91 PAD cartridge at normal temperature. To provide for high vibration resistance, the propellant grain was bonded to the case and the igniter was bonded to the top surface of the grain.

While this concept has been shown to be feasible, wide-spread application of this system to PAD cartridges is not warranted since a different single grain propellant charge would have to be extruded for each cartridge type.

UNCLASSIFIED

1. Propellant Actuated Devices
2. Vibration Resistance
3. Propellant-Mass Burning Rate
4. Propellant Ignition

I. FA Report R-1688
II. Levy, M. E.
White, W.
III. OMS 4110.16.8100.1.33

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

UNCLASSIFIED